Recent Advances in Functional Neuroimaging: Possible Bioethical Collisions

Anthony D. Wagner, PhD

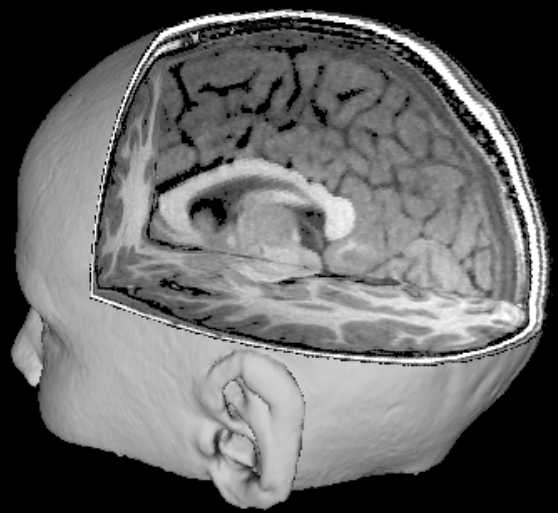
Professor of Psychology and Neuroscience
Co-Director, Stanford Center for Cognitive and Neurobiological Imaging (CNI)
Stanford University

Overview

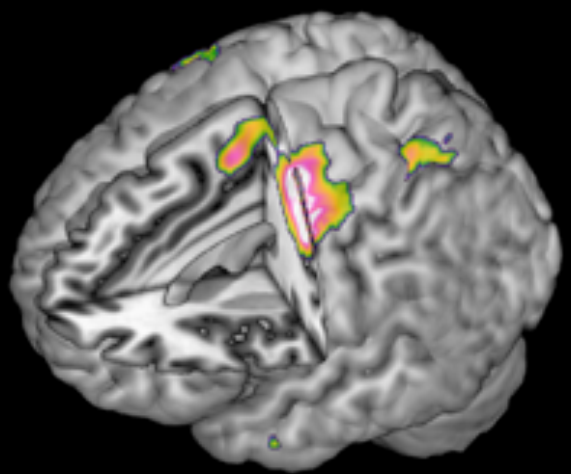
- Functional vs. Structural Neuroimaging
- Detecting Mental States
  - Functional MRI-based Lie Detection
  - Functional MRI-based Memory Detection
- Detecting Consciousness: Diagnostic and Prognostic Utility
- Neuroprediction
  - Predicting Stress Responses in Soldiers – An Exemplar

Human Neuroimaging

- Structural
  - Measures of brain anatomy / tissue composition
  - e.g., Structural MRI; Diffusion Tensor Imaging



- Functional
  - Direct and indirect measures of brain activity
  - e.g., Functional MRI; PET; EEG



Overview

- Functional vs. Structural Neuroimaging
- Detecting Mental States
  - Functional MRI-based Lie Detection
  - Functional MRI-based Memory Detection
- Detecting Consciousness: Diagnostic and Prognostic Utility
- Neuroprediction
  - Predicting Stress Responses in Soldiers – An Exemplar

Functional MRI (fMRI) & Lie Detection

WIRED SUBSCRIBE » SECTIONS » BLOGS » REVIEWS » VIDEO » HOW-T

Sign In | RSS Feeds

WIRED SCIENCE

NEWS FOR YOUR NEURONS

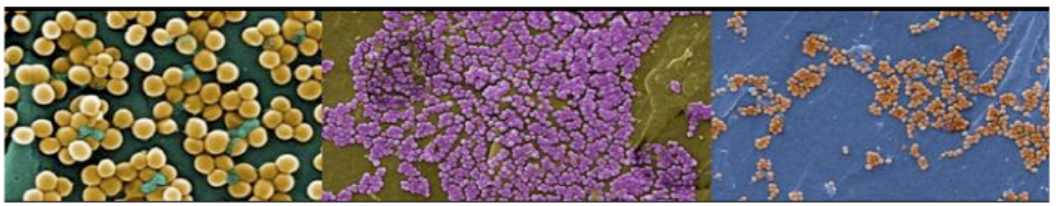
MRI Lie Detection to Get First Day in Court

By Alexis Madrigal | March 16, 2009 | 5:41 pm | Categories: Brains and Behavior

Stanford Center for Law & the Biosciences Blog

FRONT PAGE CLB PEOPLE

ABOUT THE STANFORD CENTER FOR LAW AND THE BIOSCIENCES



← No Lie MRI being offered as evidence in court

Non-Prescription Usage of ADHD Meds at One University →

Request to admit No Lie MRI report in California case is withdrawn

March 25, 2009 · 1 Comment

The Center for Law and Biosciences received this very gracious (and unnecessary!) thank you letter today from the dependent's counsel, Gary Seiser. I speak on behalf of Emily, Hank and myself when I say it was a pleasure assisting you, Gary. We are very happy with the outcome. To see the background on this case that has been made public, see Emily's blog entry here and the Wired article covering the story, here. — Teneille

RECENT POSTS

- Rising Health Care Costs in America
- Patients, Researchers File Suit to Invalidate Patents on Breast Cancer Genes
- Virtue, or virtuoso
- Low-Salt Legislation in NYC
- Update on Indian BEOS case: Accused released on bail

To search, type and hit enter

Analysis of fMRI Lie Detection Literature

(Wagner (2010), In: *A Judge's Guide to Neuroscience*)

No relevant published data unambiguously answer whether fMRI-based neuroscience methods can detect lies at the individual-instance level.

No relevant data on the sensitivity and specificity of fMRI-based lie detection.

The Published Literature (circa May 2010) — 32 peer-reviewed papers in total (28 unique data sets)

- 21 exclusively report *group-level* data
  - cannot answer whether fMRI can detect individual lies

- 11 report whether they can detect if an *individual* is "lying"
  - fundamental methodological limitations render these studies uninformative

“Memory Detection”: Mumbai, India

HOME PAGE | MY TIMES | TODAY'S PAPER | VIDEO | MOST POPULAR | TIMES TOPICS

The New York Times — Asia Pacific

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

AFRICA | AMERICAS | ASIA PACIFIC | EUROPE | MIDDLE EAST

India’s Novel Use of Brain Scans in Courts Is Debated

By ANAND GIRIDHARADAS
Published: September 14, 2008

E-MAIL
PRINT
REPRINTS
SHARE

ARTICLE TOOLS SPONSORED BY

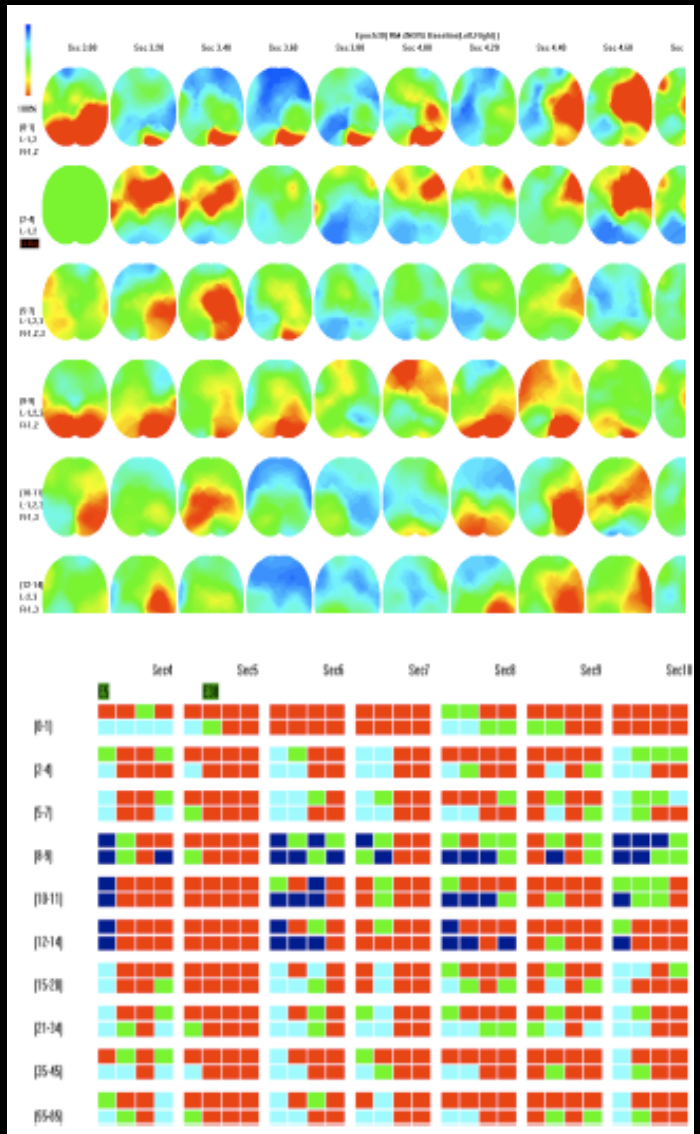
MUMBAI, India — The new technology is, to its critics, Orwellian. Others view it as a silver bullet against terrorism that could render waterboarding and other harsh interrogation methods obsolete. Some scientists predict the end of lying as we know it.

Related

Times Topics: India

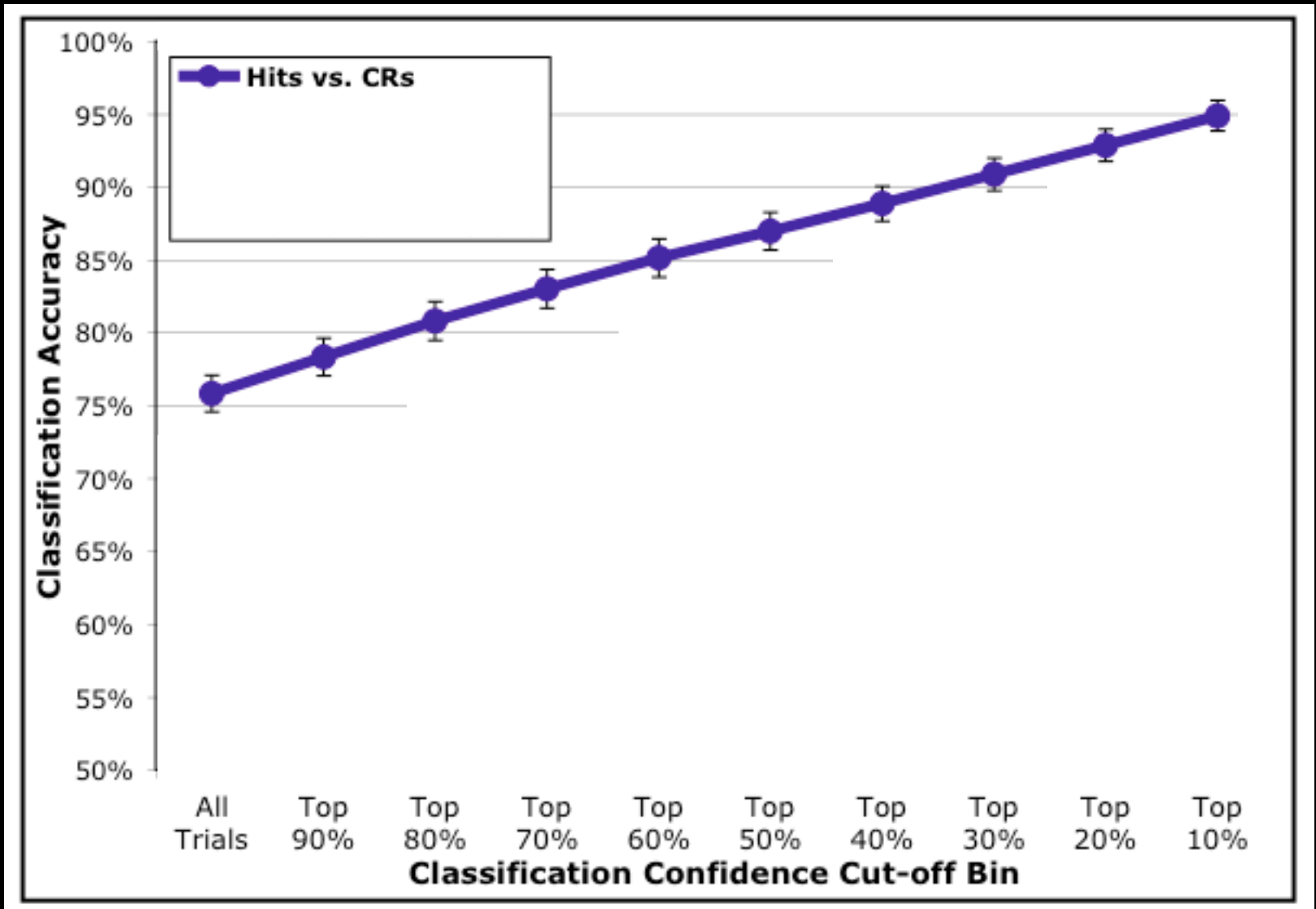
Now, well before any consensus on the technology’s readiness, India has become the first country to convict someone of a crime relying on evidence from this controversial machine: a brain scanner that produces images of the human mind in action and is said to reveal signs that a suspect remembers details of the crime in question.

For years, scientists have peered into the brain and sought to identify deception. They have shot infrared beams through liars’ heads, placed them in giant magnetic resonance imaging machines and used scanners to track their eyeballs. Since the Sept. 11 attacks, the United States has plowed money into brain-based lie detection in the hope of producing more fruitful counterterrorism investigations.



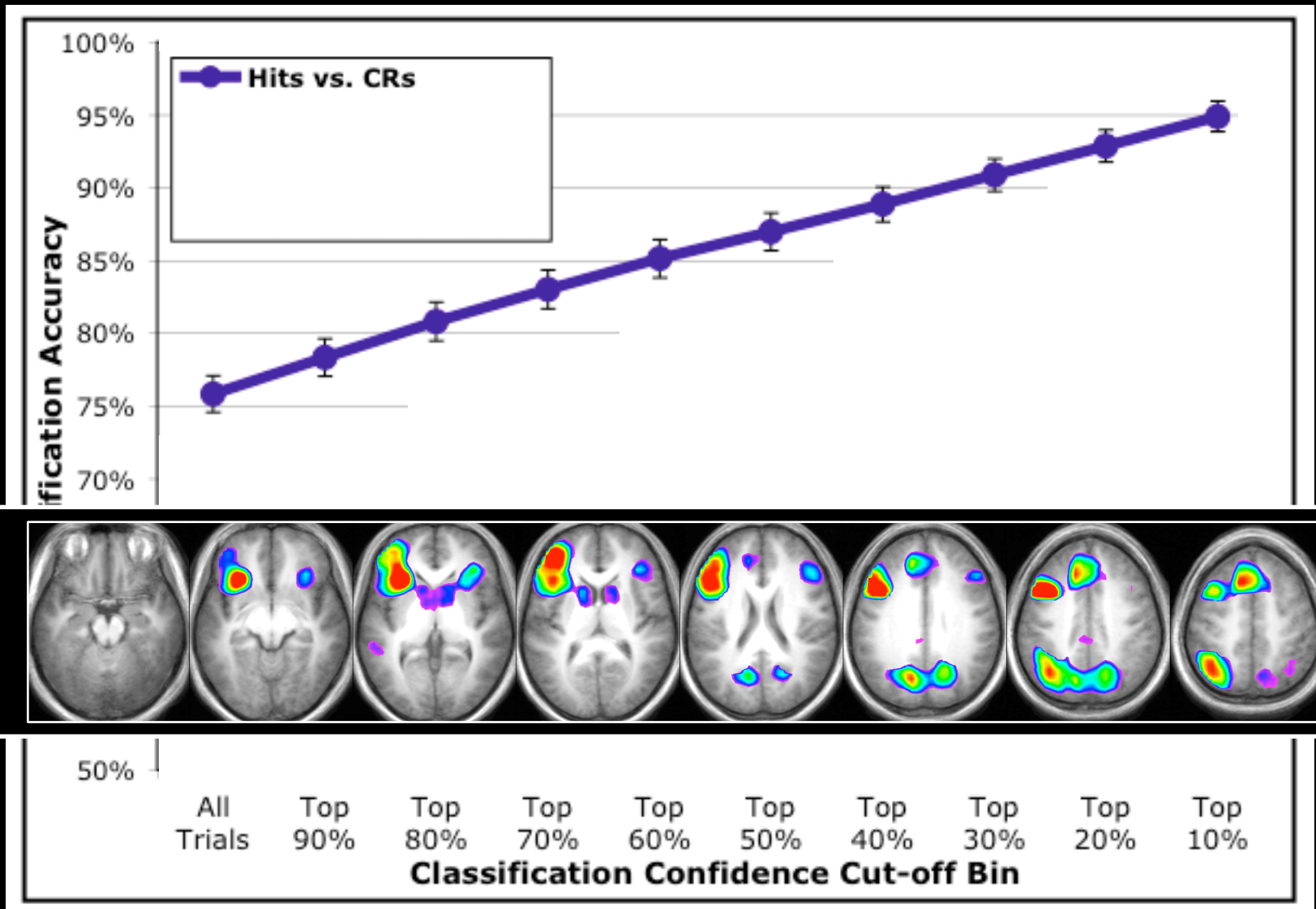
Can fMRI Detect Memories?

Rissman, Greely, & Wagner (2010), *PNAS*



Can fMRI Detect Memories?

Rissman, Greely, & Wagner (2010), *PNAS*



Can fMRI Detect Memories?
Initial Conclusions

1) Yes: Under highly-controlled conditions, fMRI can discriminate between whether someone is remembering or not with reasonably high accuracy.

2) Not well: Under highly-controlled conditions, fMRI poorly discriminates between true vs. false memory and poorly detects past experience when the subject fails to remember.

3) Source memory? Unclear whether fMRI can identify the source of a memory (e.g., participation in an event vs. learning of event from the media)

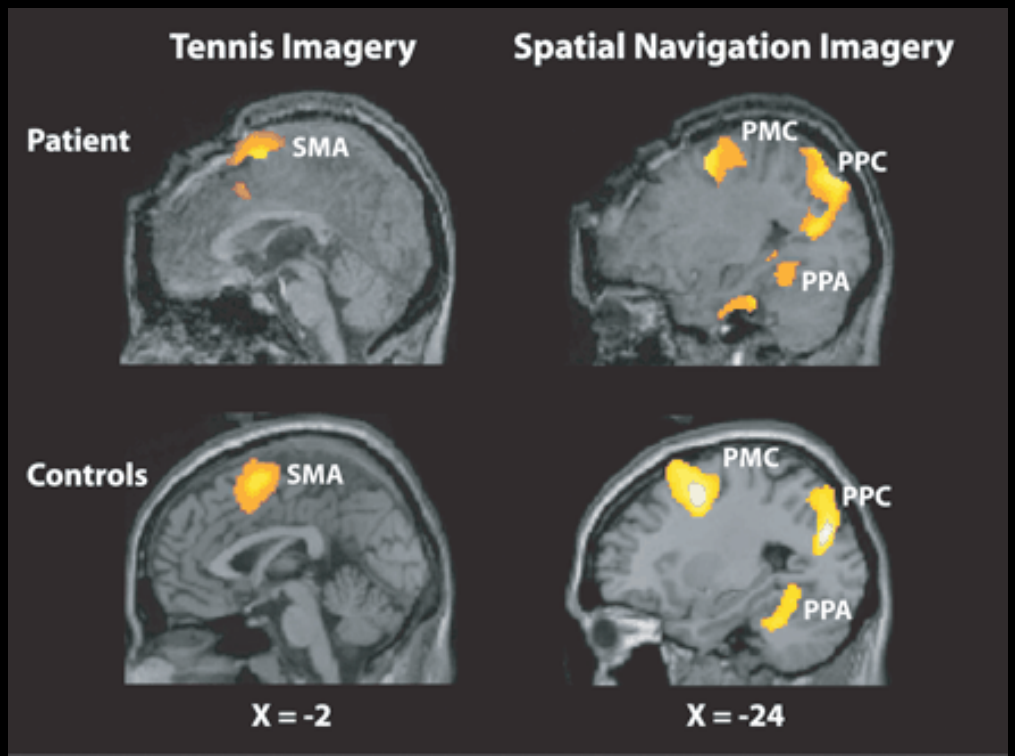
4) Countermeasures? Subject strategies may dramatically alter classifier success.

5) Complicating factors: Retention interval; Practice effects; Emotional significance; Motivation; Stress; Group effects (e.g., older adults or children)

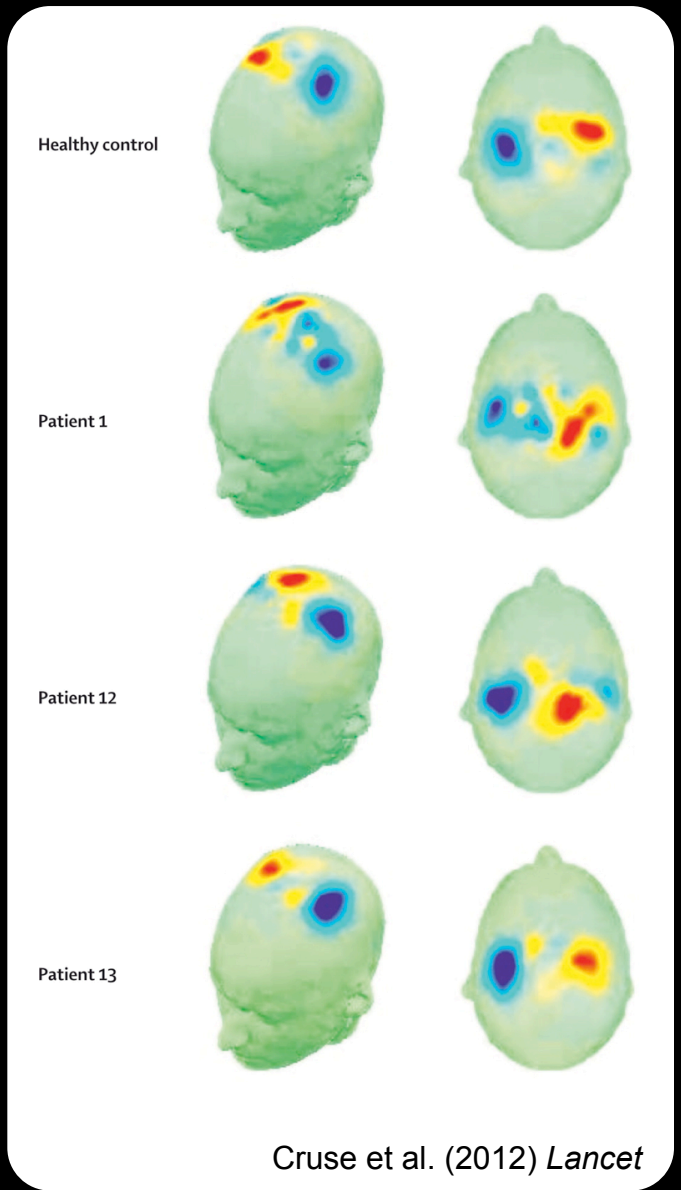
Overview

- Functional vs. Structural Neuroimaging
- Detecting Mental States
  - Functional MRI-based Lie Detection
  - Functional MRI-based Memory Detection
- Detecting Consciousness: Diagnostic and Prognostic Utility
- Neuroprediction
  - Predicting Stress Responses in Soldiers – An Exemplar

Detecting Awareness: Disorders of Consciousness



Owen et al. (2006) *Science*

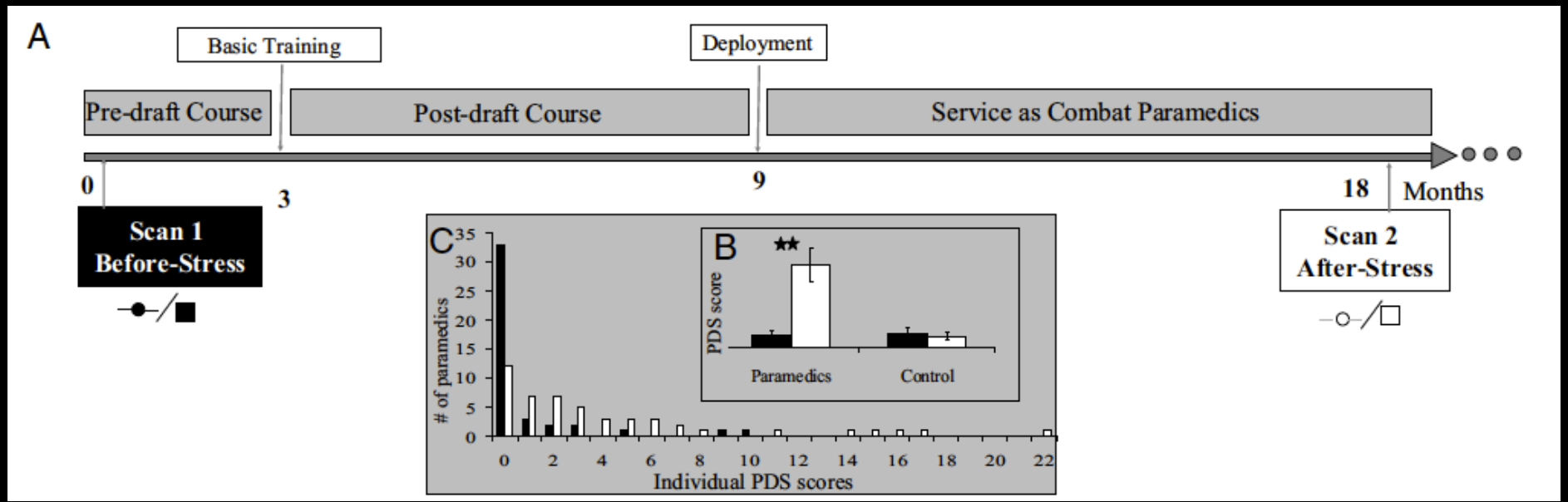


Cruse et al. (2012) *Lancet*

Overview

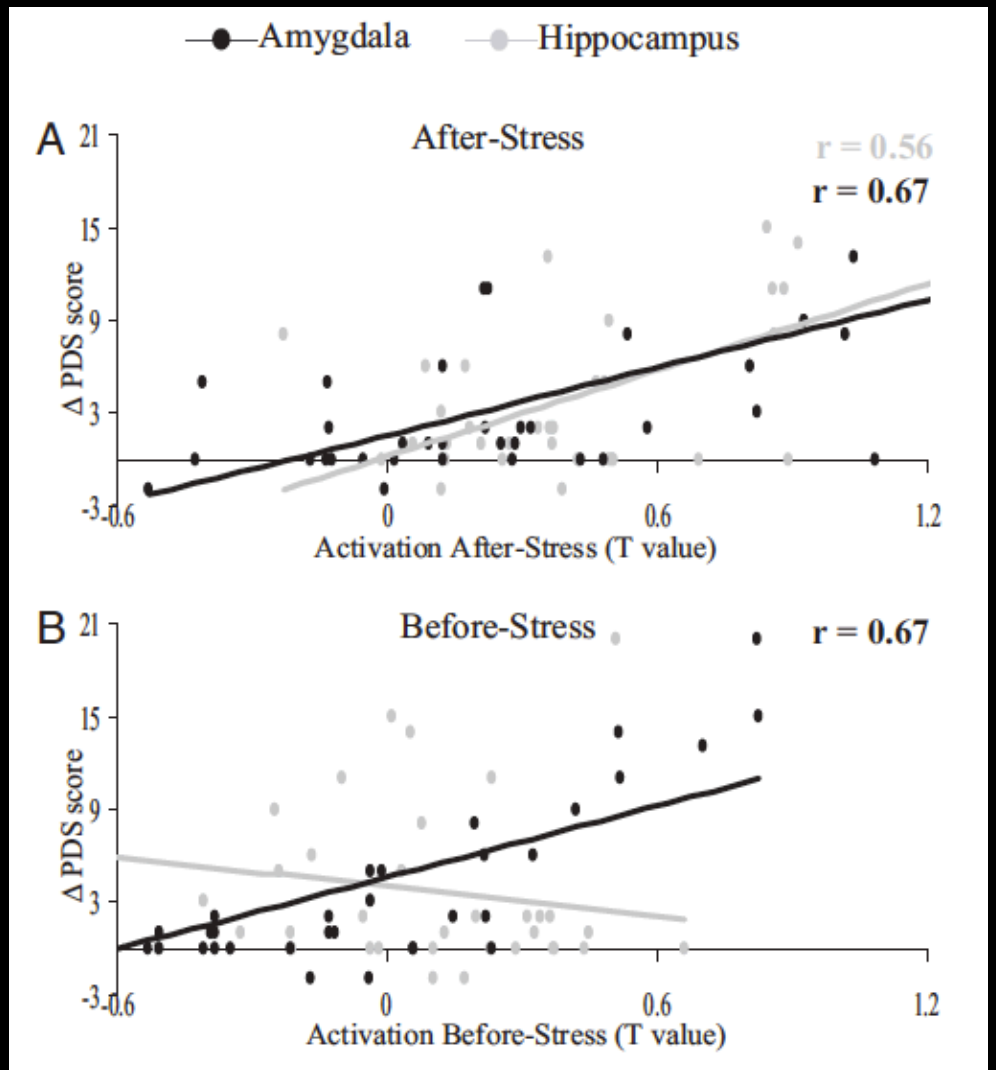
- Functional vs. Structural Neuroimaging
- Detecting Mental States
  - Functional MRI-based Lie Detection
  - Functional MRI-based Memory Detection
- Detecting Consciousness: Diagnostic and Prognostic Utility
- Neuroprediction
  - Predicting Stress Responses in Soldiers – An Exemplar

Neuroprediction in Soldiers: fMRI Data Pre-IDF Predict Stress Post-IDF



Admon et al. (2009) *PNAS*

Neuroprediction in Soldiers: fMRI Data Pre-IDF Predict Stress Post-IDF



Admon et al. (2009) *PNAS*

Overview

- Functional vs. Structural Neuroimaging
- Detecting Mental States
  - Functional MRI-based Lie Detection
  - Functional MRI-based Memory Detection
- Detecting Consciousness: Diagnostic and Prognostic Utility
- Neuroprediction
  - Predicting Stress Responses in Soldiers – An Exemplar